

WE CLAIM:

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- Sub A1
1. A railroad tie comprising:  
a railroad tie having at least four longitudinal sides, two end faces and a longitudinal axis, wherein said tie is made from wood, concrete or polymeric material, and wherein at least one longitudinal side has an arrangement of concave shapes in the surface thereof, said shapes having a depth of at least 1/8 of an inch and having sidewalls which are at an angle of less than 90°.
  2. A railroad tie according to claim 1, wherein said tie is made from polymeric material.
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  - Sub A2
  3. A railroad tie according to claim 2, wherein said concave shapes are in the form of truncated cones.
  4. A railroad tie according to claim 2, wherein said concave shapes are truncated pyramidal shapes.
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  5. A railroad tie according to claim 3, wherein the sides of the truncated cone shapes are at an angle of 30-60 degrees with respect to said at least one longitudinal side.
  6. A railroad tie according to claim 4, wherein the sides of the truncated pyramidal shapes are at an angle of 30-60 degrees with respect to said at least one longitudinal side.
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  7. A railroad tie according to claim 2, wherein the concave shapes at their base have a relative diameter of 3/4 - 2 inches.
  8. A railroad tie according to claim 3, wherein the concave shapes at their base have a relative diameter of 3/4 - 2 inches.
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  9. A railroad tie according to claim 4, wherein the concave shapes at their base have a relative diameter of 3/4 - 2 inches.
  10. A railroad tie according to claim 5, wherein the concave shapes at their base have a relative diameter of 3/4 - 2 inches.
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  11. A railroad tie according to claim 6, wherein the concave shapes at their base have a relative diameter of 3/4 - 2 inches.

12. ☒ A railroad tie according to claim 2, wherein the concave shapes have a depth of  $1/4 - 1/2$  inches.

13. ☒ A railroad tie according to claim 3, wherein the concave shapes have a depth of  $1/4 - 1/2$  inches.

14. ☒ A railroad tie according to claim 4, wherein the concave shapes have a depth of  $1/4 - 1/2$  inches.

15. ☒ A railroad tie according to claim 10, wherein the concave shapes have a depth of  $1/4 - 1/2$  inches.

16. A railroad tie according to claim 11, wherein the concave shapes have a depth of  $1/4 - 1/2$  inches.

17. ☒ A railroad tie according to claim 2, wherein said tie is formed from a material comprising a polymeric component selected from polyolefins, polystyrene, rubber and mixtures thereof, and an optional filler component selected from fiber glass, mineral fillers, wood fibers, steel fibers and mixtures thereof

18. ☒ A railroad tie according to claim 17, wherein said polymer component contains HDPE.

19. ☒ A railroad tie according to claim 17, wherein said tie contains: (1) HDPE and fiberglass; (2) HDPE, polystyrene and fiberglass; (3) HDPE, polypropylene and fiber glass; (4) HDPE and talc and/or gypsum; (5) HDPE, rubber, mineral filler and fiber glass; (6) HDPE, polypropylene and wood fiber; (7) HDPE and wood fiber or (8) HDPE, polystyrene, and wood fiber.

20. ☒ A railroad tie according to claim 2, wherein said tie is formed from a plastic composite material comprising 20-50 wt% of a polystyrene component and 50-80 wt% of a polyolefin component, and said polystyrene component contains at least 90 wt% polystyrene and said polyolefin component contains at least 75 wt% high density polyethylene.

21. A railroad tie according to claim 1, wherein regions adjacent each end of said at least one longitudinal side have said concave shapes with a depth of less than 1 inch while other regions of said at least one longitudinal side have concave shapes with a depth of up to 2 inches and sidewalls at an angle of less than  $90^\circ$ .

22. A railroad tie according to claim 2, wherein regions adjacent each end of said at least one longitudinal side have said concave shapes with a depth of less than 1 inch while other regions of said at least one longitudinal side have concave shapes with a depth of up to 2 inches and sidewalls at an angle of less than 90°.

23. A railroad tie according to claim 3, wherein regions adjacent each end of said at least one longitudinal side have said concave shapes with a depth of less than 1 inch while other regions of said at least one longitudinal side have concave shapes with a depth of up to 2 inches and sidewalls at an angle of less than 90°.

24. In a method of maintaining desired spacing between railroad rails by attachment of said rails to at least one railroad tie, the improvement wherein said at least one railroad tie is in accordance with claim 2.

25. In a method of providing a weight bearing support surface for railroad rails by attachment of said rails to at least one railroad tie, the improvement wherein said at least one railroad tie is in accordance with claim 2.